



NLT Technologies, Ltd.

TFT COLOR LCD MODULE

NL160120AC27-32B

54 cm (21.3 Type)

UXGA

LVDS Interface (2 port)

DATA SHEET

DOD-PP-1480 (1st edition)

**This DATA SHEET is updated document from
PRELIMINARY DATA SHEET DOD-PP-1313(2).**

**All information is subject to change without notice.
Please confirm the sales representative before
starting to design your system.**



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NL160120AC27-32B

INTRODUCTION



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Each quality grade is designed for applications described below. Any customer who intends to use a product for application other than that of Standard is required to contact an NLT sales representative in advance.

The **Standard**: Applications as any failure, malfunction or error of the products are free from any damage to death, human bodily injury or other property (Products Safety Issue) and not related the safety of the public (Social Issues), like general electric devices.

Examples: Office equipment, audio and visual equipment, communication equipment, test and measurement equipment, personal electronic equipment, home electronic appliances, car navigation system (with no vehicle control functions), seat entertainment monitor for vehicles and airplanes, fish finder (except marine radar integrated type), PDA, etc.

The **Special**: Applications as any failure, malfunction or error of the products might directly cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and required high level reliability by conventional wisdom.

Examples: Vehicle/train/ship control system, traffic signals system, traffic information control system, air traffic control system, surgery/operation equipment monitor, disaster/crime prevention system, etc.

The **Specific**: Applications as any failure, malfunction or error of the products might severe cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and developed, designed and manufactured in accordance with the standards or quality assurance program designated by the customer who requires extremely high level reliability and quality.

Examples: Aerospace system (except seat entertainment monitor), nuclear control system, life support system, etc.

The quality grade of this product is the "**Standard**" unless otherwise specified in this document.

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL160120AC27-32B is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

Grayscale data signals from a host system (e.g. signal generator, etc.) are modulated into best form for active matrix system by a signal processing board, and sent to the driver LSIs which drive the individual TFT arrays.

The TFT array as an electro-optical switch regulates the amount of transmitted light from the backlight assembly, when it is controlled by data signals. Color images are created by regulating the amount of transmitted light through the TFT array of red, green and blue dots.

1.2 APPLICATION

- Color monitor system

1.3 FEATURES

- Ultra-wide viewing angle (Ultra-Advanced Super Fine TFT (UA-SFT))
- High luminance
- High contrast
- High resolution
- Low reflection
- Wide color gamut
- 256 gray scale in each R, G, B sub-pixel (8-bit), 16,777,216 colors
- LVDS interface
- Selectable LVDS data input map
- Small foot print
- Long life LED backlight type with an LED driver board
- Compliant with the European RoHS directive (2011/65/EU)
- Acquisition product for UL60950-1/CSA C22.2 No.60950-1-03 (File number: E170632)



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2. GENERAL SPECIFICATIONS

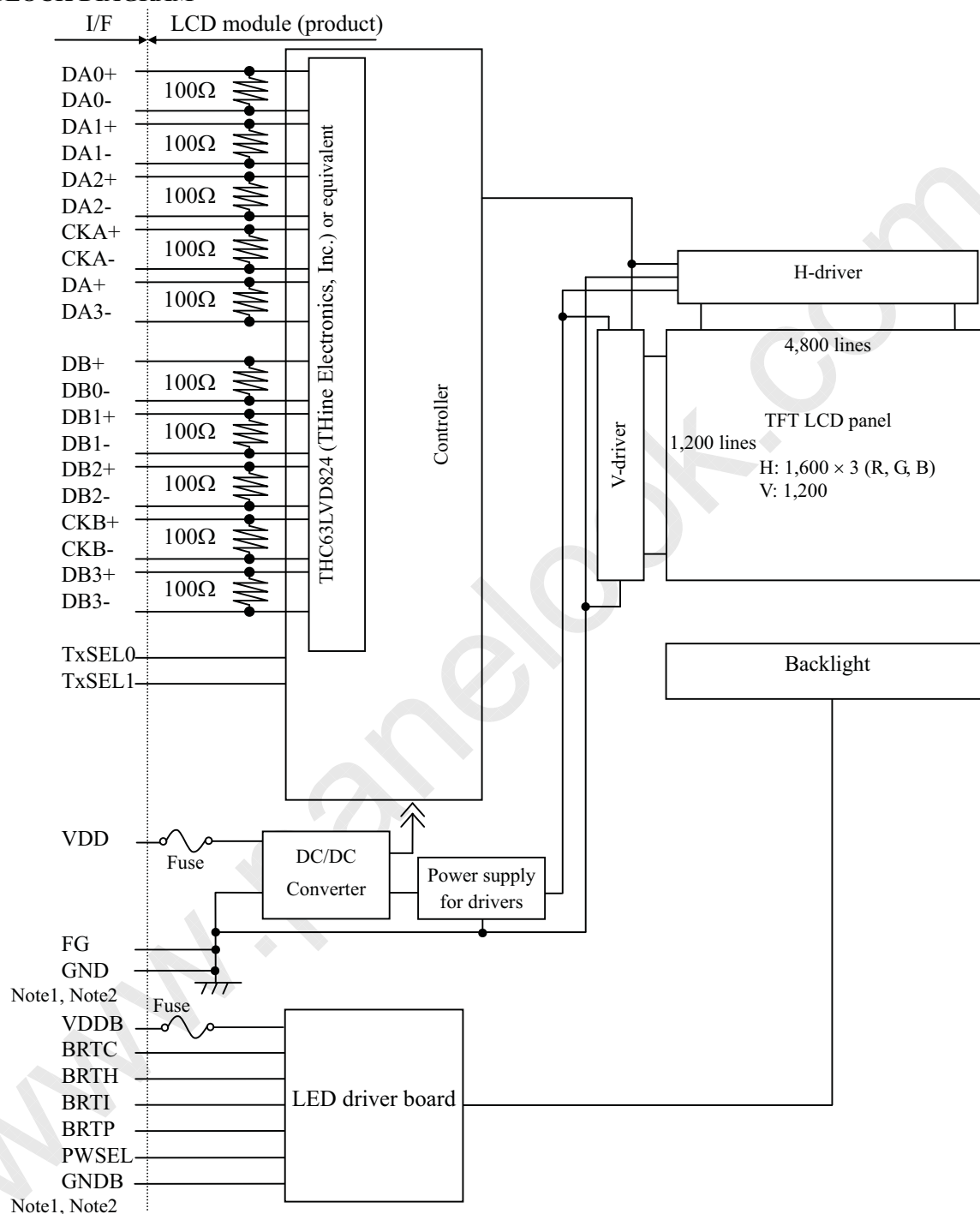
Display area	432.0 (H) × 324.0 (V) mm	
Diagonal size of display	54 cm (21.3 inches)	
Drive system	a-Si TFT active matrix	
Display color	16,777,216 colors	
Pixel	1,600 (H) × 1,200 (V) pixels (1 pixel consists of 3 sub-pixels (RGB).)	
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe	
Dot pitch	0.090 (H) × 0.270 (V) mm	
Pixel pitch	0.270 (H) × 0.270 (V) mm	
Module size	457.0 (W) × 350.0 (H) × 21.5 (D) mm (typ.)	
Weight	2,700 g (typ.)	☆
Contrast ratio	1200:1 (typ.)	
Viewing angle	At the contrast ratio ≥ 10:1 • Horizontal: Right side 88° (typ.), Left side 88° (typ.) • Vertical: Up side 88° (typ.), Down side 88° (typ.)	
Designed viewing direction	Viewing angle with optimum grayscale ($\gamma \approx$ DICOM): Normal axis (perpendicular) Note1	
Polarizer surface	Antiglare	
Polarizer pencil-hardness	2H (min.) [by JIS K5600]	
Color gamut	At LCD panel center 72 % (typ.) [against NTSC color space]	☆
Response time	$T_{on}+T_{off}$ (10% $\longleftrightarrow$ 90%) 40 ms (typ.)	☆
Luminance	At the maximum luminance control 760 cd/m ² (typ.)	
Signal system	2 ports LVDS interface (Characteristics of AC receiver THC63LVD824A THine Electronics, Inc. or equivalent) [RGB 8-bit signals, Data enable signal (DE), Dot clock (CLK)]	☆
Power supply voltage	LCD panel signal processing board: 12.0V LED driver board: 12.0V	
Backlight	LED backlight type with LED driver board	
Power consumption	At checkered flag pattern, the maximum luminance control 57 W (typ.)	☆

Note1: When the product luminance is 450cd/m², the gamma characteristic is designed to $\gamma \approx$ DICOM.

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3. BLOCK DIAGRAM



Note1: Relations between GND (Signal ground), FG (Frame ground) and GNDB (LED driver board ground) in the LCD module are as follows.

GND - FG	Connected
GND - GNDB	Not connected
FG - GNDB	Not connected

Note2: GND, FG and GNDB must be connected to customer equipment's ground, and it is recommended that these grounds be connected together in customer equipment.

Note3: Each pair of the LVDS signal has a 100Ω terminating resistance between D+ and D-.



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4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification	Unit
Module size	457.0 ±0.5 (W) × 350.0 ±0.5 (H) × 21.5 (typ., D) 23.0 (max., D) Note1, Note2	mm
Display area	432.0 (H) × 324.0 (V) Note2	mm
Weight	2,700 (typ.), 2,980 (max.)	g

Note1: Excluding warpage of the cover for LED driver board.

Note2: See "8. OUTLINE DRAWINGS".

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter			Symbol	Rating	Unit	Remarks
Power supply voltage	LCD panel signal processing board		VDD	-0.3 to +14.0	V	Ta = 25°C
	LED driver board		VDDB	-0.3 to +15.0	V	
Input voltage for signals	LCD panel signal processing board Note1		Vi	-0.3 to +3.45	V	VDD= 12.0V
	LED driver board	BRTI signal	VBI	-0.3 to +1.5	V	VDDB= 12.0V
		BRTP signal	VBP	-0.3 to +5.5	V	
		BRTC signal	VBC	-0.3 to +5.5	V	
		PWSEL signal	VBS	-0.3 to +5.5	V	
Storage temperature			Tst	-20 to +60	°C	-
Operating temperature	Front surface		TopF	0 to +60	°C	Note2
	Rear surface		TopR	0 to +60	°C	Note3
Relative humidity Note4			RH	≤ 95	%	Ta ≤ 40°C
				≤ 85	%	40°C < Ta ≤ 50°C
				≤ 70	%	50°C < Ta ≤ 55°C
Absolute humidity Note4			AH	≤ 73 Note5	g/m ³	Ta > 55°C
Operating altitude			-	≤ 5,100	m	0°C ≤ Ta ≤ 55°C
Storage altitude			-	≤ 13,600	m	-20°C ≤ Ta ≤ 60°C

Note1: DA0+/-, DA1+/-, DA2+/-, DA3+/-, CKA+/-, DB0+/-, DB1+/-, DB2+/-, DB3+/-, CKB+/-

Note2: Measured at LCD panel surface (including self-heat)

Note3: Measured at LCD module's rear shield surface (including self-heat)

Note4: No condensation

Note5: Water amount at Ta= 55°C and RH= 70%

Note6: The image quality may cause degradation in case of rapid change humidity and temperature.

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4.3 ELECTRICAL CHARACTERISTICS

4.3.1 LCD panel signal processing board

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VDD	10.8	12.0	13.2	V	-
Power supply current		IDD	-	500 Note1	700 Note2	mA	at VDD= 12.0V
Permissible ripple voltage		VRP	-	-	100	mVp-p	for VDD
Differential input threshold voltage	High	VTH	-	-	+100	mV	at VCM= 1.2V Note3, Note4
	Low	VTL	-100	-	-	mV	
Input voltage swing		VI	0	-	2.4	V	Note4
Terminating resistance		RT	-	100	-	Ω	-

Note1: Checkered flag pattern (by EIAJ ED-2522)

Note2: Pattern for maximum current

Note3: Common mode voltage for LVDS driver

Note4: DA0+/-, DA1+/-, DA2+/-, DA3+/-, CKA+/-, DB0+/-, DB1+/-, DB2+/-, DB3+/-, CKB+/-



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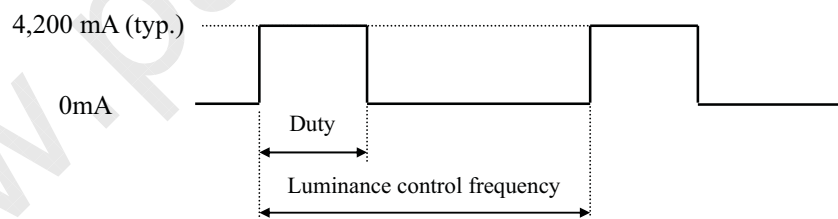
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4.3.2 LED driver board

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VDDDB	11.4	12.0	12.6	V	-
Power supply current		IDDB	-	4,200	5,800	mA	VDDDB= 12.0V, At the maximum luminance control
Input voltage for signals	BRTI signal		VBI	0	-	1.0	V
	BRTP signal	High	VBPH	2.0	-	5.25	V
		Low	VBPL	0	-	0.8	V
	BRTC signal	High	VBCH	2.0	-	5.25	V
		Low	VBCL	0	-	0.8	V
	PWSEL signal	High	VBSH	2.0	-	5.25	V
		Low	VBSL	0	-	0.8	V
Input current for signals	BRTI signal		IBI	-200	-	-100	μA
	BRTP signal	High	IBPH	-	-	1,000	μA
		Low	IBPL	-600	-	-	μA
	BRTC signal	High	IBCH	-	-	300	μA
		Low	IBCL	-300	-	-	μA
	PWSEL signal	High	IPSH	-	-	1,000	μA
		Low	IPSL	-600	-	-	μA

4.3.3 LED driver board current wave



At the maximum luminance control: 100% to at the minimum luminance control: 1%.
Luminance control frequency: 270 Hz (typ.)

Note1: Luminance control frequency indicate the input pulse frequency, when select the external pulse control. See "4.6.2 Detail of BRTP timing".

Note2: The power supply lines (VDDDB and GNDB) have large ripple voltage during luminance control. See "4.3.4 Power supply voltage ripple".

There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on. Put a capacitor (5,000 to 6,000μF) between the power supply lines (VDDDB and GNDB) to reduce the noise, if the noise occurred in the circuit..

NLT Technologies, Ltd.**NL160120AC27-32B****4.3.4 Power supply voltage ripple**

This product works, even if the ripple voltage levels are beyond the permissible values as following the table, but there might be noise on the display image.

Power supply voltage		Ripple voltage (Measure at input terminal of power supply)	Note1 Unit
VDD	12.0V	≤ 100	mVp-p
VDDDB	12.0V	≤ 200	mVp-p

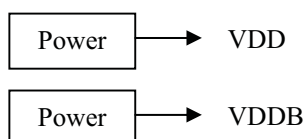
Note1: The permissible ripple voltage includes spike noise.

Note2: The load variation influence does not include.

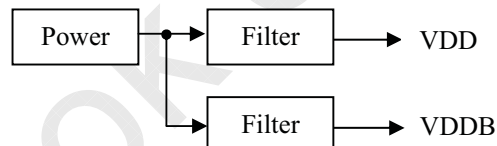


Example of the power supply connection

a) Separate the power supply



b) Put in the filter

**4.3.5 Fuse**

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VDD	FCC16132AB	KAMAYA ELECTRIC Co., Ltd.	1.25A	2.5A, 5 seconds maximum	Note1
			32V		
VDDDB	CCF1N10	KOA Corporation	10A	20 A, 1 seconds maximum	-
			60V		
	TF16AT5.00T		5.0A	10 A, 5 seconds maximum	-
			32V		

Note1: The power supply capacity should be more than the fusing current. If it is less than the fusing current, the fuse may not blow in a short time, and then nasty smell, smoke and so on may occur.

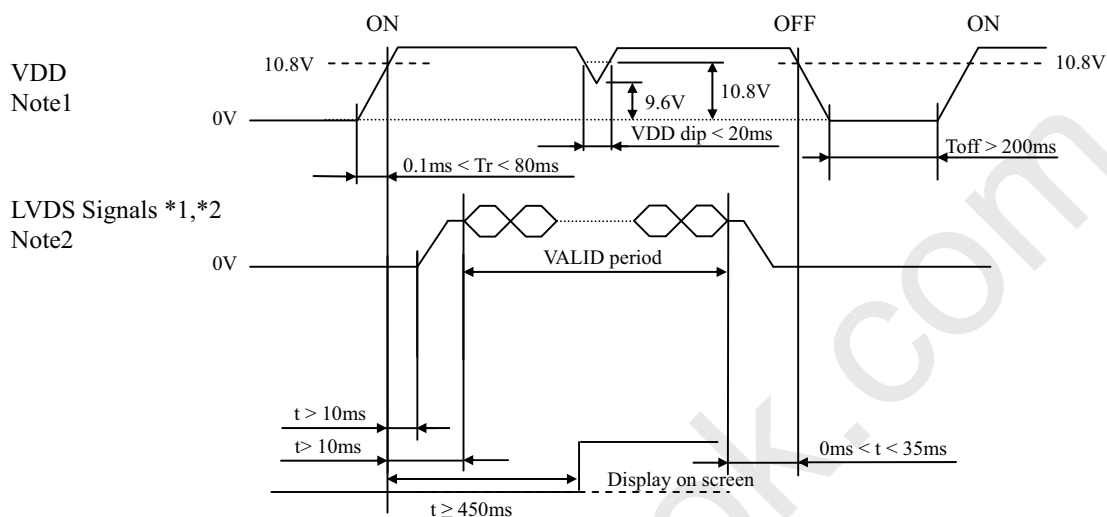


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4.4 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 LCD panel signal processing board



*1: DA0+/-, DA1+/-, DA2+/-, DA3+/-, CKA+/-, DB0+/-, DB1+/-, DB2+/-, DB3+/- and CKB+/-

*2: LVDS signals should be measured at the terminal of 100Ω resistance.

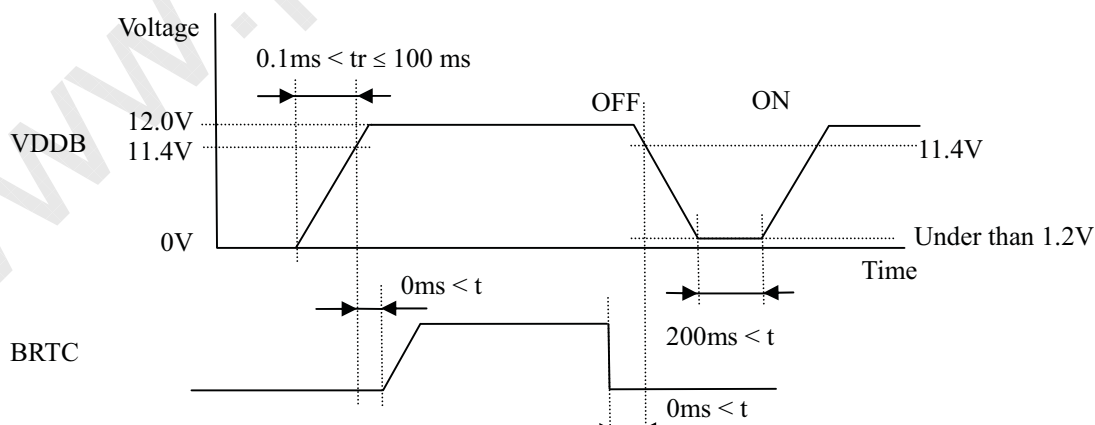
Note1: If there is a voltage variation (voltage drop) at the rising edge of VDD below 10.8V, there is a possibility that a product does not work due to a protection circuit. ☆

Note2: LVDS signals must be set to Low or High-impedance, except the VALID period (See above sequence diagram), in order to avoid the circuitry damage.

If some of signals are cut while this product is working, even if the signal input to it once again, it might not work normally. If a customer stops the display and function signals, VDD also must be shut down. ☆

Note3: The backlight should be turned on within the valid period of LVDS signals, in order to avoid unstable data display.

4.4.2 LED driver board



Note1: The backlight should be turned on within the valid period of LVDS signals, in order to avoid unstable data display.

Note2: If tr is more than 100 ms, the backlight will be turned off by a protection circuit for LED driver board. ☆

Note3: When VDDDB is 0V or BRTC is Low, PWSEL must be set to Low or Open.



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4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): DF19G-30P-1H (56) (HIROSE ELECTRIC Co.,Ltd.)

Adaptable plug: DF19-30S-1C (HIROSE ELECTRIC Co.,Ltd.)

Pin No.	Symbol	Signal	Remarks				
1	DA0-	Pixel data A0	Odd pixel data input (LVDS DIFFERENTIAL DATA) Note1				
2	DA0+						
3	DA1-	Pixel data A1	Odd pixel data input (LVDS DIFFERENTIAL DATA) Note1				
4	DA1+						
5	DA2-	Pixel data A2	Odd pixel data input (LVDS DIFFERENTIAL DATA) Note1				
6	DA2+						
7	GND	Ground	Signal ground Note2				
8	CKA-	Pixel clock	Odd pixel clock input (LVDS DIFFERENTIAL DATA) Note1				
9	CKA+						
10	DA3-	Pixel data A3	Odd pixel data input (LVDS DIFFERENTIAL DATA) Note1				
11	DA3+						
12	DB0-	Pixel data B0	Even pixel data input (LVDS DIFFERENTIAL DATA) Note1				
13	DB0+						
14	GND	Ground	Signal ground Note2				
15	DB1-	Pixel data B1	Even pixel data input (LVDS DIFFERENTIAL DATA) Note1				
16	DB1+						
17	GND	Ground	Signal ground Note2				
18	DB2-	Pixel data B2	Even pixel data input (LVDS DIFFERENTIAL DATA) Note1				
19	DB2+						
20	CKB-	Pixel clock	Even pixel clock input (LVDS DIFFERENTIAL DATA) Note1				
21	CKB+						
22	DB3-	Pixel data B3	Even pixel data input (LVDS DIFFERENTIAL DATA) Note1				
23	DB3+						
24	GND	Ground	Signal ground Note2				
25	TxSEL0	Select LVDS data input map	Note3, Note4	TxSEL1		TxSEL0	Mode
26	TxSEL1			Open	Open	A	
				Open	Low	B	
				Low	Open	C	
				Low	Low	A	
27	GND	Ground	Signal ground Note2				
28	VDD	Power supply	12V Note2				
29	VDD						
30	VDD						

Note1: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

Note2: All GND and VDD terminals should be used without any non-connected lines.

Note3: This terminal is pulled-up in the product.

Note4: See "4.7 LVDS DATA INPUT MAP".

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4.5.2 LED driver board

CN201 socket (LCD module side): DF3Z-10P-2H (2*) (HIROSE ELECTRIC Co., Ltd.)

Adaptable plug: DF3-10S-2C (HIROSE ELECTRIC Co., Ltd.)

Pin No.	Symbol	Function	Description
1	GNDB	LED driver board ground	Note1
2	GNDB		
3	GNDB		
4	GNDB		
5	GNDB		
6	VDDDB	Power supply	Note1
7	VDDDB		
8	VDDDB		
9	VDDDB		
10	VDDDB		

Note1: All VDDDB and GNDB terminals should be used without any non-connected lines.

CN202 socket (LCD module side): IL-Z-9PL-SMTYE (Japan Aviation Electronics Industry Limited (JAE))

Adaptable plug: IL-Z-9S-S125C3 (Japan Aviation Electronics Industry Limited (JAE))

Pin No.	Symbol	Function	Description
1	GNDB	LED driver board ground	Note1
2	GNDB		
3	N.C.	-	Keep this pin Open.
4	BRTC	Backlight ON/OFF control signal	High or Open: Backlight ON Low: Backlight OFF
5	BRTH	Luminance control terminal	Note2
6	BRTI		
7	BRTP	BRTP signal	
8	GNDB	LED driver board ground	Note1
9	PWSEL	Selection of luminance control signal method	Note2, Note3

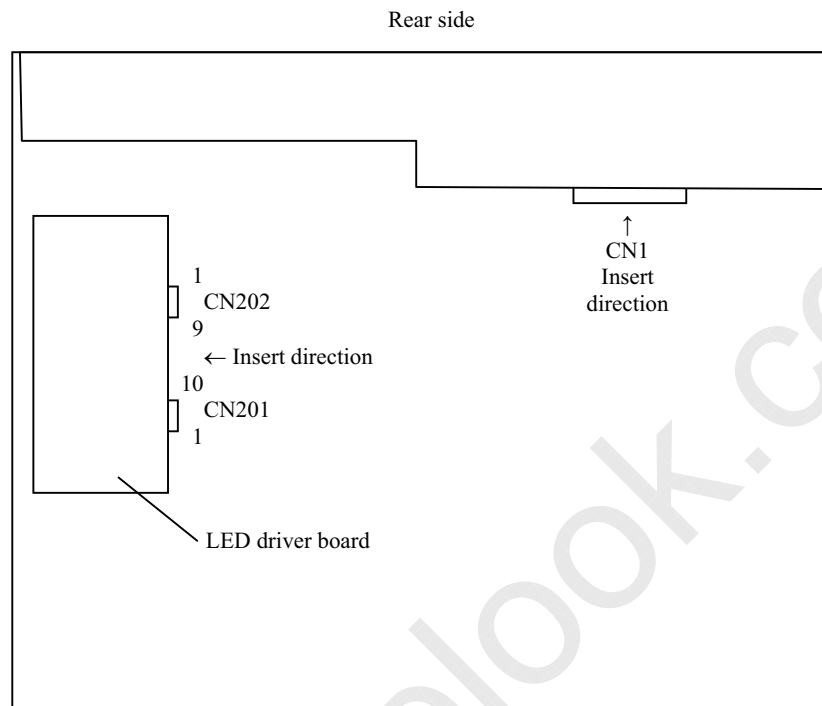
Note1: All GNDB terminals should be used without any non-connected lines.

Note2: See "4.6.1 LUMINANCE CONTROL".

Note3: When VDDDB is 0V or BRTC is Low, PWSEL must be set to Low or Open.

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4.5.3 Positions of socket

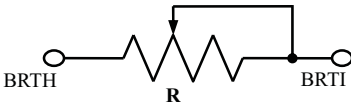


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4.6 LUMINANCE CONTROL

4.6.1 Luminance control methods

Method	Adjustment and luminance ratio	PWSEL terminal	B RTP terminal						
Variable resistor control Note1	• Adjustment The variable resistor (R) for luminance control should be 10kΩ ±5%, 1/10W. Minimum point of the resistance is the minimum luminance and maximum point of the resistance is the maximum luminance. The resistor (R) must be connected between BRTH-BRTI terminals.  • Luminance ratio Note3 <table><tr><th>Resistance</th><th>Luminance ratio</th></tr><tr><td>0 Ω</td><td>0% (Min. Luminance)</td></tr><tr><td>10 kΩ</td><td>100% (Max. Luminance)</td></tr></table>	Resistance	Luminance ratio	0 Ω	0% (Min. Luminance)	10 kΩ	100% (Max. Luminance)	High or Open	Open
Resistance	Luminance ratio								
0 Ω	0% (Min. Luminance)								
10 kΩ	100% (Max. Luminance)								
Voltage control Note1	• Adjustment Voltage control method works, when BRTH terminal is 0V and VBI voltage is input between BRTI-BRTH terminals. This control method can carry out continuation adjustment of luminance. Luminance is the maximum when BRTI terminal is Open. • Luminance ratio Note3 <table><tr><th>BRTI Voltage (VBI)</th><th>Luminance ratio</th></tr><tr><td>0V</td><td>0% (Min. Luminance)</td></tr><tr><td>1.0V</td><td>100% (Max. Luminance)</td></tr></table>	BRTI Voltage (VBI)	Luminance ratio	0V	0% (Min. Luminance)	1.0V	100% (Max. Luminance)		
BRTI Voltage (VBI)	Luminance ratio								
0V	0% (Min. Luminance)								
1.0V	100% (Max. Luminance)								
Pulse width modulation Note1 Note2 Note4	• Adjustment Pulse width modulation (PWM) method works, when PWSEL terminal is Low and PWM signal (B RTP signal) is input into B RTP terminal. The luminance is controlled by duty ratio of B RTP signal. • Luminance ratio Note3 <table><tr><th>Duty ratio</th><th>Luminance ratio</th></tr><tr><td>0.01</td><td>1% (Min. Luminance) (At frequency: 325 Hz)</td></tr><tr><td>1.0</td><td>100% (Max. Luminance)</td></tr></table>	Duty ratio	Luminance ratio	0.01	1% (Min. Luminance) (At frequency: 325 Hz)	1.0	100% (Max. Luminance)	Low	B RTP signal
Duty ratio	Luminance ratio								
0.01	1% (Min. Luminance) (At frequency: 325 Hz)								
1.0	100% (Max. Luminance)								

Note1: In case of the variable resistor control method and the voltage control method, noises may appear on the display image depending on the input signals timing for LCD panel signal processing board.

Use PWM method, if interference noises appear on the display image!

Note2: The LED driver board will stop working, if the Low period of B RTP signal is more than 50ms while BRTC signal is High or Open. Then the backlight will not turn on anymore, even if B RTP signal is input again. This is not out of order. The LED driver board will start to work when power is supplied again.

Note3: These data are the target values.

Note4: See "4.6.2 Detail of B RTP timing".



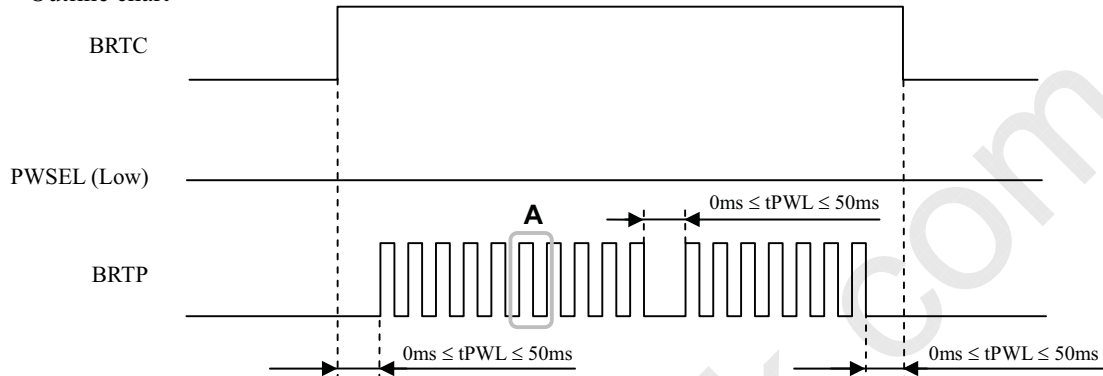
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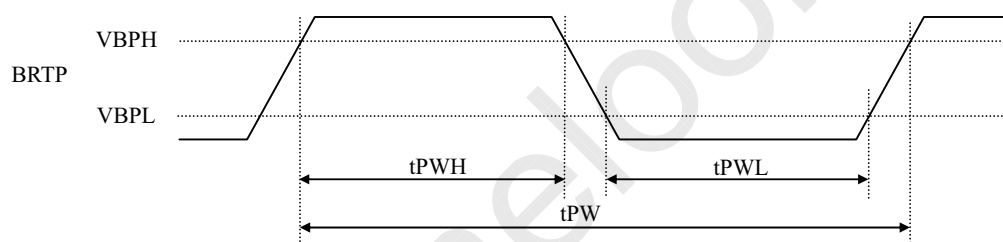
4.6.2 Detail of BRTTP timing

(1) Timing diagrams

• Outline chart



• Detail of A part



(2) Each parameter

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Luminance control frequency	FL	185	-	1,000	Hz	Note1, Note2
External PWM pulse width	tPWH	30	-	-	μs	Note1, Note3



Note1: Definition of parameters is as follows.

$$FL = \frac{1}{tPW} \quad DL = \frac{tPWH}{tPW}$$

Note2: See the following formula for luminance control frequency.

$$\text{Luminance control frequency} = 1/tv \times (n+0.25)$$

$$n = 1, 2, 3 \dots \dots$$

tv: Vertical cycle (See "4.9.1 Timing characteristics".)

The interference noise of luminance control frequency and input signal frequency for LCD panel signal processing board may appear on a display. Set up luminance control frequency so that the interference noise does not appear!

Note3: See "4.6.1 Luminance control methods".



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4.7 LVDS DATA INPUT MAP

4.7.1 Mode A

Input data Note1		Transmitter				CN1	
		Pin	THC63LVDF83D	Pin	THC63LVD823B		
Odd pixel data	RA2 →	51	TA0	53	R12	Note 2	
	RA3 →	52	TA1	54	R13	TA1- →	1 DA0-
	RA4 →	54	TA2	57	R14	TA1+ →	2 DA0+
	RA5 →	55	TA3	58	R15		
	RA6 →	56	TA4	59	R16	TB1- →	3 DA1-
	RA7 →	3	TA5	60	R17	TB1+ →	4 DA1+
	GA2 →	4	TA6	63	G12		
	GA3 →	6	TB0	64	G13	TC1- →	5 DA2-
	GA4 →	7	TB1	65	G14	TC1+ →	6 DA2+
	GA5 →	11	TB2	66	G15		7 GND
	GA6 →	12	TB3	67	G16	TCLK1- →	8 CKA-
	GA7 →	14	TB4	68	G17	TCLK1+ →	9 CKA+
	BA2 →	15	TB5	73	B12		
	BA3 →	19	TB6	74	B13	TD1- →	10 DA3-
	BA4 →	20	TC0	75	B14	TD1+ →	11 DA3+
	BA5 →	22	TC1	76	B15		
	BA6 →	23	TC2	77	B16		
	BA7 →	24	TC3	78	B17		
	Note3 RSVD →	27	TC4	7	RSVD		
	Note3 RSVD →	28	TC5	8	RSVD		
	DE →	30	TC6	9	DE		
	RA0 →	50	TD0	51	R10		
	RA1 →	2	TD1	52	R11		
	GA0 →	8	TD2	61	G10		
	GA1 →	10	TD3	62	G11		
	BA0 →	16	TD4	69	B10		
	BA1 →	18	TD5	70	B11		
	RSVD →	25	TD6	-			
	CLK →	31	CLKIN	10	CLK		
Even pixel data	RB2 →	51	TA0	81	R22	TA2- →	12 DB0-
	RB3 →	52	TA1	82	R23	TA2+ →	13 DB0+
	RB4 →	54	TA2	83	R24		14 GND
	RB5 →	55	TA3	84	R25	TB2- →	15 DB1-
	RB6 →	56	TA4	85	R26	TB2+ →	16 DB1+
	RB7 →	3	TA5	86	R27		17 GND
	GB2 →	4	TA6	91	G22	TC2- →	18 DB2-
	GB3 →	6	TB0	92	G23	TC2+ →	19 DB2+
	GB4 →	7	TB1	93	G24		
	GB5 →	11	TB2	94	G25	TCLK2- →	20 CKB-
	GB6 →	12	TB3	95	G26	TCLK2+ →	21 CKB+
	GB7 →	14	TB4	96	G27		
	BB2 →	15	TB5	99	B22		
	BB3 →	19	TB6	100	B23	TD2- →	22 DB3-
	RB4 →	20	TC0	1	B24	TD2+ →	23 DB3+
	RB5 →	22	TC1	2	B25		24 GND
	RB6 →	23	TC2	5	B26		25 TxSEL0
	RB7 →	24	TC3	6	B27		26 TxSEL1
	Note3 RSVD →	27	TC4	-			27 GND
	Note3 RSVD →	28	TC5	-			28 VDD
	Note3 RSVD →	30	TC6	-			29 VDD
	RB0 →	50	TD0	79	R20		30 VDD
	RB1 →	2	TD1	80	R21		
	GB0 →	8	TD2	89	G20		
	GB1 →	10	TD3	90	G21		
	BB0 →	16	TD4	97	B20		
	BB1 →	18	TD5	98	B21		
	Note3 RSVD →	25	TD6	-			
	CLK →	31	CLKIN	-			

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4.7.3 Mode C

Input data		Note1	Transmitter		CN1	
			Pin	DS90CF383, C385		Pin Symbol
Odd pixel data	RA0	→	51	TXIN0	Note2	1 DA0-
	RA1	→	52	TXIN1	TA1- →	2 DA0+
	RA2	→	54	TXIN2	TA1+ →	
	RA3	→	55	TXIN3		
	RA4	→	56	TXIN4	TB1- →	3 DA1-
	RA5	→	3	TXIN6	TB1+ →	4 DA1+
	GA0	→	4	TXIN7		
	GA1	→	6	TXIN8	TC1- →	5 DA2-
	GA2	→	7	TXIN9	TC1+ →	6 DA2+
	GA3	→	11	TXIN12		7 GND
	GA4	→	12	TXIN13	TCLK1- →	8 CKA-
	GA5	→	14	TXIN14	TCLK1+ →	9 CKA+
	BA0	→	15	TXIN15		
	BA1	→	19	TXIN18	TD1- →	10 DA3-
	BA2	→	20	TXIN19	TD1+ →	11 DA3+
	BA3	→	22	TXIN20		
	BA4	→	23	TXIN21		
	BA5	→	24	TXIN22		
	Note 3	→	27	TXIN24		
	Note 3	→	28	TXIN25		
	DE	→	30	TXIN26		
	RA6	→	50	TXIN27		
	RA7	→	2	TXIN5		
	GA6	→	8	TXIN10		
	GA7	→	10	TXIN11		
	BA6	→	16	TXIN16		
	BA7	→	18	TXIN17		
	Note 3	→	25	TXIN23		
	CLK	→	31	CLKIN		
Even pixel data	RB0	→	51	TXIN0		
	RB1	→	52	TXIN1	TA2- →	12 DB0-
	RB2	→	54	TXIN2	TA2+ →	13 DB0+
	RB3	→	55	TXIN3		14 GND
	RB4	→	56	TXIN4	TB2- →	15 DB1-
	RB5	→	3	TXIN6	TB2+ →	16 DB1+
	GB0	→	4	TXIN7		17 GND
	GB1	→	6	TXIN8	TC2- →	18 DB2-
	GB2	→	7	TXIN9	TC2+ →	19 DB2+
	GB3	→	11	TXIN12		
	GB4	→	12	TXIN13	TCLK2- →	20 CKB-
	GB5	→	14	TXIN14	TCLK2+ →	21 CKB+
	BB0	→	15	TXIN15		
	BB1	→	19	TXIN18	TD2- →	22 DB3-
	BB2	→	20	TXIN19	TD2+ →	23 DB3+
	BB3	→	22	TXIN20		24 GND
	BB4	→	23	TXIN21		25 TxSEL0
	BB5	→	24	TXIN22		26 TxSEL1
	Note 3	→	27	TXIN24		27 GND
	Note 3	→	28	TXIN25		28 VDD
	Note 3	→	30	TXIN26		29 VDD
	RB6	→	50	TXIN27		30 VDD
	RB7	→	2	TXIN5		
	GB6	→	8	TXIN10		
	GB7	→	10	TXIN11		
	BB6	→	16	TXIN16		
	BB7	→	18	TXIN17		
	Note 3	→	25	TXIN23		
	CLK	→	31	CLKIN		

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Note1: LSB (Least Significant Bit) – RA0, GA0, BA0, RB0, GB0, BB0

MSB (Most Significant Bit) – RA7, GA7, BA7, RB7, GB7, BB7

Note2: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

Note3: Input signal RSVD is not used inside the product, but do not keep pin open to avoid noise problem.

4.8 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display in equivalent to 16,777,216 colors in 256 gray scales in each RGB sub-pixel. Also the relation between display colors and input data signals is as the following table.

Display colors		Data signal (0: Low level, 1: High level)																							
		RA7	RA6	RA5	RA4	RA3	RA2	RA1	RA0	GA7	GA6	GA5	GA4	GA3	GA2	GA1	GA0	BA7	BA6	BA5	BA4	BA3	BA2	BA1	BA0
		RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0	GB7	GB6	GB5	GB4	GB3	GB2	GB1	GB0	BB7	BB6	BB5	BB4	BB3	BB2	BB1	BB0
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑					⋮								⋮								⋮			
	↓					⋮								⋮								⋮			
	bright	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	↑					⋮								⋮								⋮			
	↓					⋮								⋮								⋮			
	bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
Blue gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	↑					⋮								⋮								⋮			
	↓					⋮								⋮								⋮			
	bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
Blue		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

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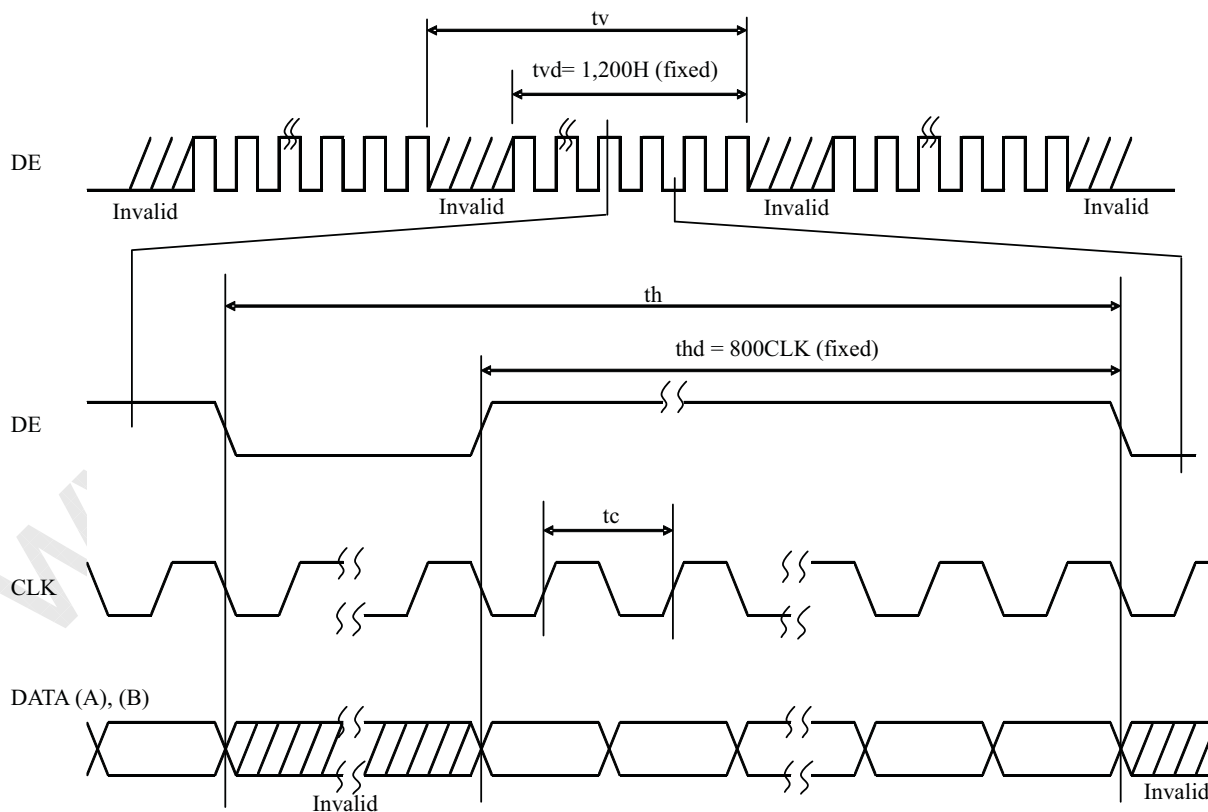
4.9 INPUT SIGNAL TIMINGS

4.9.1 Timing characteristics

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency	1/ tc	60.0	64.5	65.0	MHz	LVDS transmitter input
	Pulse width	tc	15.38	15.5	-	ns	
	Duty	-	See the data sheet of LVDS transmitter.			-	-
	Rise, fall	-				ns	
Horizontal	Cycle	th	13.1	13.3	19.2	μ s	Note1
			848	860	1,156	CLK	
	Display period	thd	800			CLK	-
Vertical	Cycle	1/tv	59	60	61	Hz	-
		tv	1,206	1,250	-	H	
	Display period	tvd	1,200			H	-
DE, DATA	Setup time	-	See the data sheet of LVDS transmitter.			ns	-
	Hold time	-				ns	
	Rise, fall	-				ns	

Note1: During operation, fluctuation of horizontal cycle should be within ± 1 CLK.

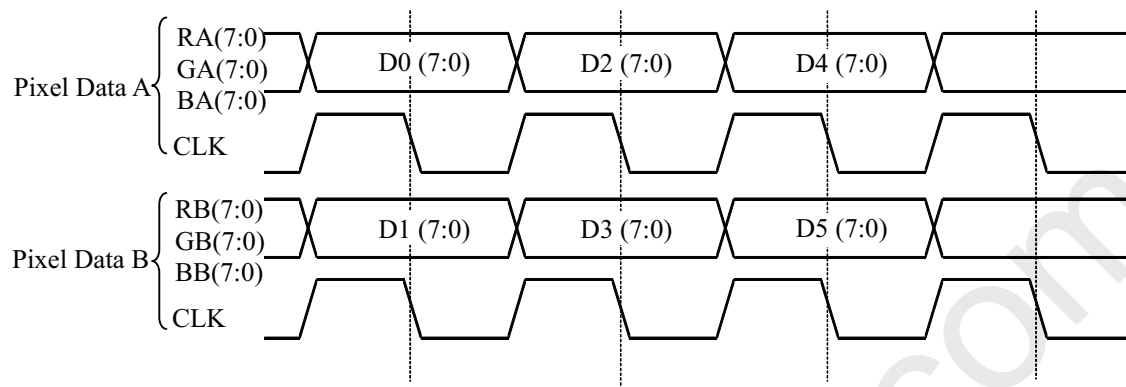
4.9.2 Input signal timing chart



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4.10 LVDS DATA TRANSMISSION METHOD

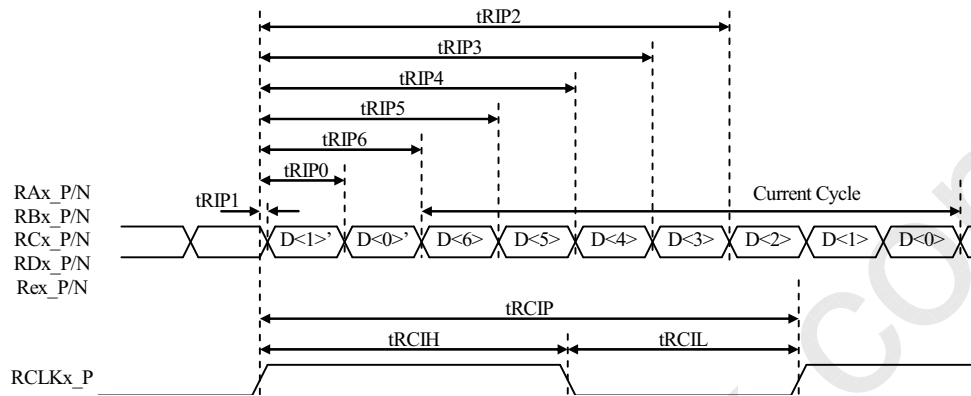


4.11 LVDS Rx AC SPEC

Symbol	Parameter	Min.	Typ.	Max.	Units
t_{RCIP}	RCLKx_P Period	11.76	—	40.0	ns
t_{RCIH}	RCLKx_P High pulse width	—	$\frac{4}{7} t_{RCIP}$	—	ns
t_{RCIL}	RCLKx_P Low pulse width	—	$\frac{3}{7} t_{RCIP}$	—	ns
t_{RMG}	Receiver Data Input Margin fCLKIN=60MHz	-0.65	—	0.65	ns
	fCLKIN=65MHz				
	fCLKIN=66MHz				
t_{RIP1}	Input Data Position0	$- t_{RMG} $	0.0	$+ t_{RMG} $	ns
t_{RIP0}	Input Data Position1	$\frac{t_{RCIP}}{7} - t_{RMG} $	$\frac{t_{RCIP}}{7}$	$\frac{t_{RCIP}}{7} + t_{RMG} $	ns
t_{RIP6}	Input Data Position2	$2 \frac{t_{RCIP}}{7} - t_{RMG} $	$2 \frac{t_{RCIP}}{7}$	$2 \frac{t_{RCIP}}{7} + t_{RMG} $	ns
t_{RIP5}	Input Data Position3	$3 \frac{t_{RCIP}}{7} - t_{RMG} $	$3 \frac{t_{RCIP}}{7}$	$3 \frac{t_{RCIP}}{7} + t_{RMG} $	ns
t_{RIP4}	Input Data Position4	$4 \frac{t_{RCIP}}{7} - t_{RMG} $	$4 \frac{t_{RCIP}}{7}$	$4 \frac{t_{RCIP}}{7} + t_{RMG} $	ns
t_{RIP3}	Input Data Position5	$5 \frac{t_{RCIP}}{7} - t_{RMG} $	$5 \frac{t_{RCIP}}{7}$	$5 \frac{t_{RCIP}}{7} + t_{RMG} $	ns
t_{RIP2}	Input Data Position6	$6 \frac{t_{RCIP}}{7} - t_{RMG} $	$6 \frac{t_{RCIP}}{7}$	$6 \frac{t_{RCIP}}{7} + t_{RMG} $	ns

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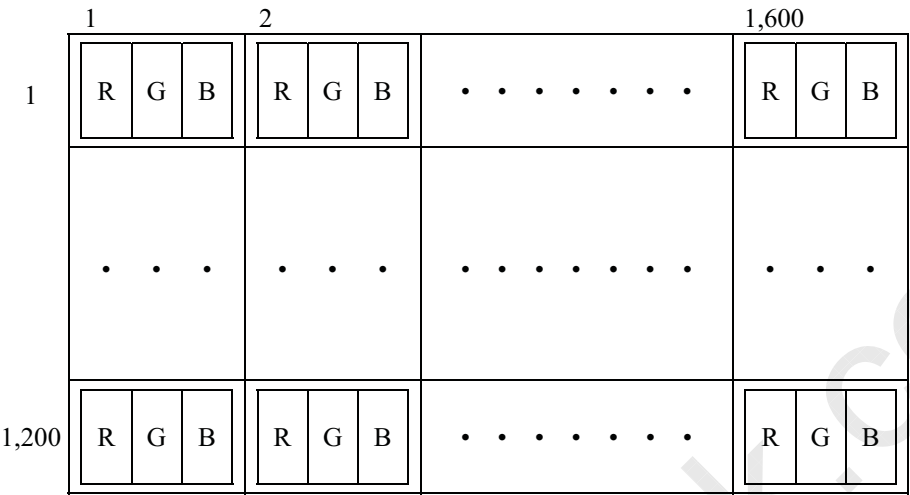
4.12 DISPLAY POSITIONS

Odd pixel: RA= Red data
GA= Green data
BA= Blue data

Even pixel: RB= Red data
GB= Green data
BB= Blue data

D (1, 1)			D (2, 1)				
RA	GA	BA	RB	GB	BB		
D(1, 1)	D(2, 1)	...	D(X, 1)	...	D(1599, 1)	D(1600, 1)	
D(1, 2)	D(2, 2)	...	D(X, 2)	...	D(1599, 2)	D(1600, 2)	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	
D(1, Y)	D(2, Y)	...	D(X, Y)	...	D(1599, Y)	D(1600, Y)	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	
D(1, 1199)	D(2, 1199)	...	D(X, 1199)	...	D(1599, 1199)	D(1600, 1199)	
D(1, 1200)	D(2, 1200)	...	D(X, 1200)	...	D(1599, 1200)	D(1600, 1200)	

4.13 PIXEL ARRANGNMENT



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4.14 OPTICS

4.14.1 Optical characteristics

(Note1, Note2)

Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	580	760	-	cd/m ²	BM-5A or SR-3	Note3
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	1,000	1,200	-	-	BM-5A or SR-3	Note3 Note5
Luminance uniformity		255/255 gray scale θR= 0°, θL= 0°, θU= 0°, θD= 0°	LU ₂₅₅	80	-	-	%	BM-5A or SR-3	Note4 Note6
Chromaticity	White	x coordinate	W _x	0.269	0.299	0.329	-	SR-3	Note3 Note8
		y coordinate	W _y	0.285	0.315	0.345	-		
	Red	x coordinate	R _x	-	0.65	-	-		
		y coordinate	R _y	-	0.33	-	-		
	Green	x coordinate	G _x	-	0.29	-	-		
		y coordinate	G _y	-	0.60	-	-		
	Blue	x coordinate	B _x	-	0.15	-	-		
		y coordinate	B _y	-	0.07	-	-		
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space	C	65	72	-	%	SR-3	Note3
Response time		Black to White	T _{on}	-	20	30	ms	BM-5A	Note3 Note8
		White to Black	T _{off}	-	20	30	ms		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10	θR	70	88	-	°	BM-5A or EZ Contrast	Note3 Note9
	Left	θU= 0°, θD= 0°, CR≥ 10	θL	70	88	-	°		
	Up	θR= 0°, θL= 0°, CR≥ 10	θU	70	88	-	°		
	Down	θR= 0°, θL= 0°, CR≥ 10	θD	70	88	-	°		

Note1: These are initial characteristics.

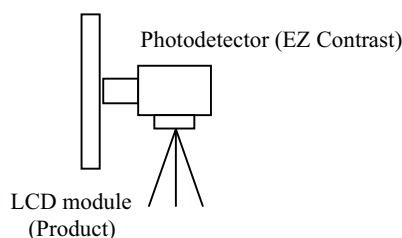
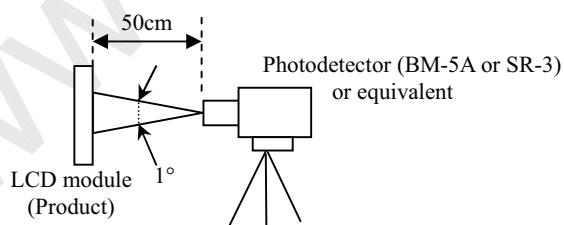
Note2: Measurement conditions are as follows.

Ta = 25°C, VDD = 12.0V, VDDB = 12.0V, PWM: Duty 100%, Display mode: UXGA,

Horizontal cycle = 1/75.19 kHz, Vertical cycle = 1/60.0Hz

Optical characteristics are measured after 20 minutes from working the product, in the dark room.

Also measurement methods are as follows.



Note3: Product surface temperature at the maximum luminance control: TopF = 32°C

Note4: Product surface temperature at 450cd/m² luminance control: TopF = 30°C

Temperature difference in display area: Δ10°C ☆

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Note5: See "4.14.2 Definition of contrast ratio".

Note6: See "4.14.3 Definition of luminance uniformity".

Note7: These coordinates are found on CIE 1931 chromaticity diagram.

Note8: See "4.14.4 Definition of response times".

Note9: See "4.14.5 Definition of viewing angles".

4.14.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

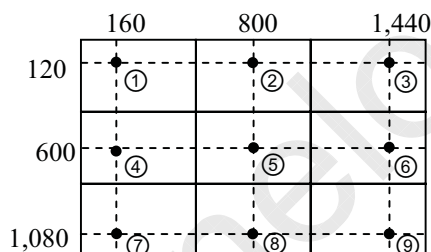
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.14.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

$$\text{Luminance uniformity (LU)} = \frac{\text{Minimum luminance from ① to ⑤}}{\text{Maximum luminance from ① to ⑤}}$$

The luminance is measured at near the 9 points shown below.



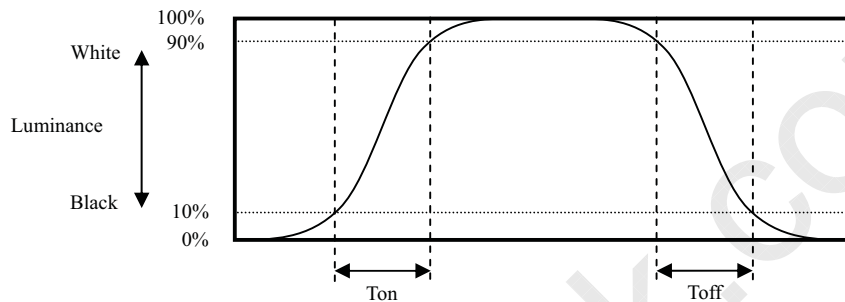
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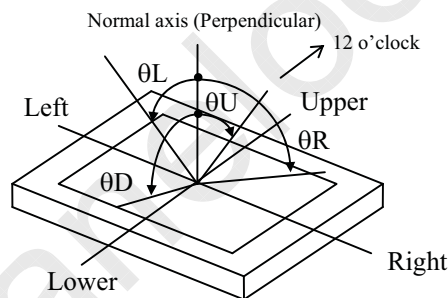
4.14.4 Definition of response times

Response time is measured at the time when the luminance changes from "black" to "white", or "white" to "black" on the same screen point, by photo-detector. Ton is the time when the luminance changes from 10% up to 90%. Also Toff is the time when the luminance changes from 90% down to 10% (See the following diagram.).

Product surface temperature at the maximum luminance control: TopF = 35°C



4.14.5 Definition of viewing angles



5. ESTIMATED LUMINANCE LIFETIME

The luminance lifetime is the time from initial luminance to half-luminance.

This lifetime is the estimated value, and is not guarantee value.

Condition		Estimated luminance lifetime (Life time expectancy) Note1, Note2, Note3	Unit
LED elementary substance	25°C (Ambient temperature of the product) Continuous operation, PWM: Duty 100%	70,000	h
	60°C (Temperature of the product front or rear panel) Continuous operation, PWM: Duty 100%	60,000	



Note1: Life time expectancy is mean time to half-luminance.

Note2: Estimated luminance lifetime is not the value for an LCD module but the value for LED elementary substance.

Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

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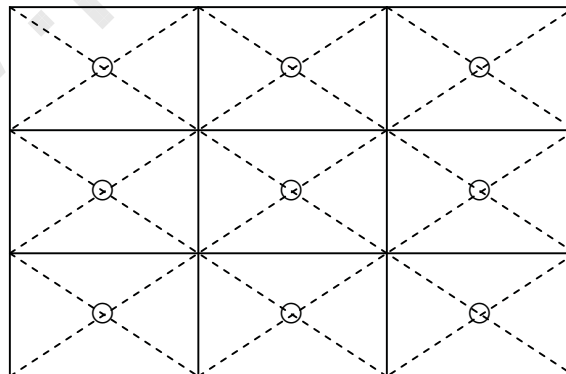
6. RELIABILITY TESTS

Test item		Condition	Judgment	Note1
High temperature and humidity (Operation)		① $60 \pm 2^{\circ}\text{C}$, RH= 60%, 500hours ② Display data is white.	No display malfunctions	Note2
Heat cycle (Operation)		① $0 \pm 3^{\circ}\text{C}$ 1hour $60 \pm 3^{\circ}\text{C}$ 1hour ② 50cycles, 4hours/cycle ③ Display data is white.		
Thermal shock (Non operation)		① $-20 \pm 3^{\circ}\text{C}$ 30minutes $60 \pm 3^{\circ}\text{C}$ 30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes.		
Vibration (Non operation)		① 5 to 100Hz, 11.76m/s^2 ② 1 minute/cycle ③ X, Y, Z directions ④ 10 times each directions	No display malfunctions No physical damages	
Mechanical shock (Non operation)		① 294m/s^2 , 11ms ② X, Y, Z directions ③ 3 times each directions		
ESD (Operation)		① 150pF, 150Ω , $\pm 10\text{kV}$ ② 9 places on a panel surface ③ 10 times each places at 1 sec interval	No display malfunctions	
Low pressure	Non-operation	① 15 kPa (Equivalent to altitude 13,600m) ② $-20^{\circ}\text{C} \pm 3^{\circ}\text{C}$ 24 hours ③ $+60^{\circ}\text{C} \pm 3^{\circ}\text{C}$ 24 hours	No display malfunctions	Note2
	Operation	① 53.3 kPa (Equivalent to altitude 5,100m) ② $0^{\circ}\text{C} \pm 3^{\circ}\text{C}$ 24 hours ③ $+60^{\circ}\text{C} \pm 3^{\circ}\text{C}$ 24 hours		

Note1: Display and appearance are checked under environmental conditions equivalent to the inspection conditions of defect criteria.

Note2: Luminance: 450cd/m^2 at luminance control.

Note3: See the following figure for discharge points



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7. PRECAUTIONS

7.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "7.2 CAUTIONS" and "7.3 ATTENTIONS"!**



This sign has the meaning that a customer will be injured or the product will sustain damage if the customer practices wrong operations.



This sign has the meaning that a customer will be injured if the customer practices wrong operations.

7.2 CAUTIONS



*** Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass. (Shock: Equal to or no greater than 294m/s^2 and equal to or no greater than 11ms, Pressure: Equal to or no greater than 19.6N ($\phi 16\text{mm}$ jig))**



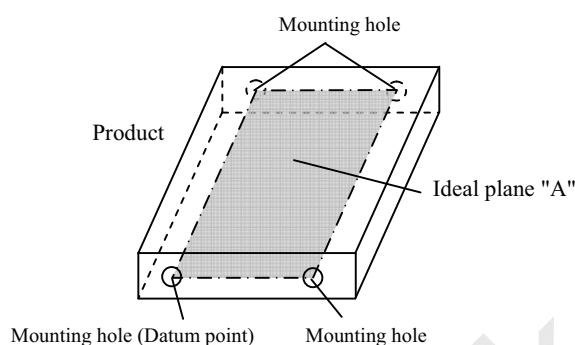
7.3 ATTENTIONS

7.3.1 Handling of the product

- ① Take hold of both ends without touching the circuit board when the product (LCD module) is picked up from inner packing box to avoid broken down or misadjustment, because of stress to mounting parts on the circuit board.
- ② Do not hook nor pull cables such as lamp cable, and so on, in order to avoid any damage.
- ③ When the product is put on the table temporarily, display surface must be placed downward.
- ④ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
- ⑤ The torque for product mounting screws must never exceed 0.735N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be $\leq 5.0\text{mm}$.

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- ⑥ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area). Bends or twist described above and undue stress to any portion may cause display mura. Recommended installing method: Ideal plane "A" is defined by one mounting hole (datum point) and other mounting holes. The ideal plane "A" should be the same plane within ± 0.3 mm.



- ⑦ Do not press or rub on the sensitive product surface. When cleaning the product surface, wipe it with a soft dry cloth.
- ⑧ Do not push or pull the interface connectors while the product is working.
- ⑨ When handling the product, use of an original protection sheet on the product surface (polarizer) is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the polarizer.
- ⑩ Usually liquid crystals don't leak through the breakage of glasses because of the surface tension of thin layer and the construction of LCD panel. But, if you contact with liquid crystal by any chance, please wash it away with soap and water.

7.3.2 Environment

- ① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box with antistatic pouch in room temperature to avoid dusts and sunlight, when storing the product.
- ② In order to prevent dew condensation occurred by temperature difference, the product packing box must be opened after enough time being left under the environment of an unpacking room. Evaluate the storage time sufficiently because dew condensation is affected by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with the original packing state after a customer receives the package)
- ③ Do not operate in high magnetic field. If not, circuit boards may be broken.
- ④ This product is not designed as radiation hardened.



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7.3.3 Characteristics

The following items are neither defects nor failures.

- ① Response time, luminance and color may be changed by ambient temperature.
- ② Display mura, flickering, vertical streams or tiny spots may be observed depending on display patterns.
- ③ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed pattern is displayed on the screen.
- ④ The display color may be changed depending on viewing angle because of the use of condenser sheet in the backlight.
- ⑤ Optical characteristics may be changed depending on input signal timings.

7.3.4 Others

- ① All GND, GNDB, VDD and VDDB terminals should be used without any non-connected lines.
- ② Do not disassemble a product or adjust variable resistors.
- ③ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NLT for repairing and so on.
- ④ The LCD module by itself or integrated into end product should be packed and transported with display in the vertical position. Otherwise the display characteristics may be degraded.
- ⑤ The information of China RoHS directive six hazardous substances or elements in this product is as follows. ☆

China RoHS directive six hazardous substances or elements					
Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr VI)	Polybrominated Biphenyls (PBB)	Polybrominated Biphenyl Ethers (PBDE)
×	○	○	○	○	○

Note1: ○: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is equal or below the limitation level of SJ/T11363-2006 standard regulation.

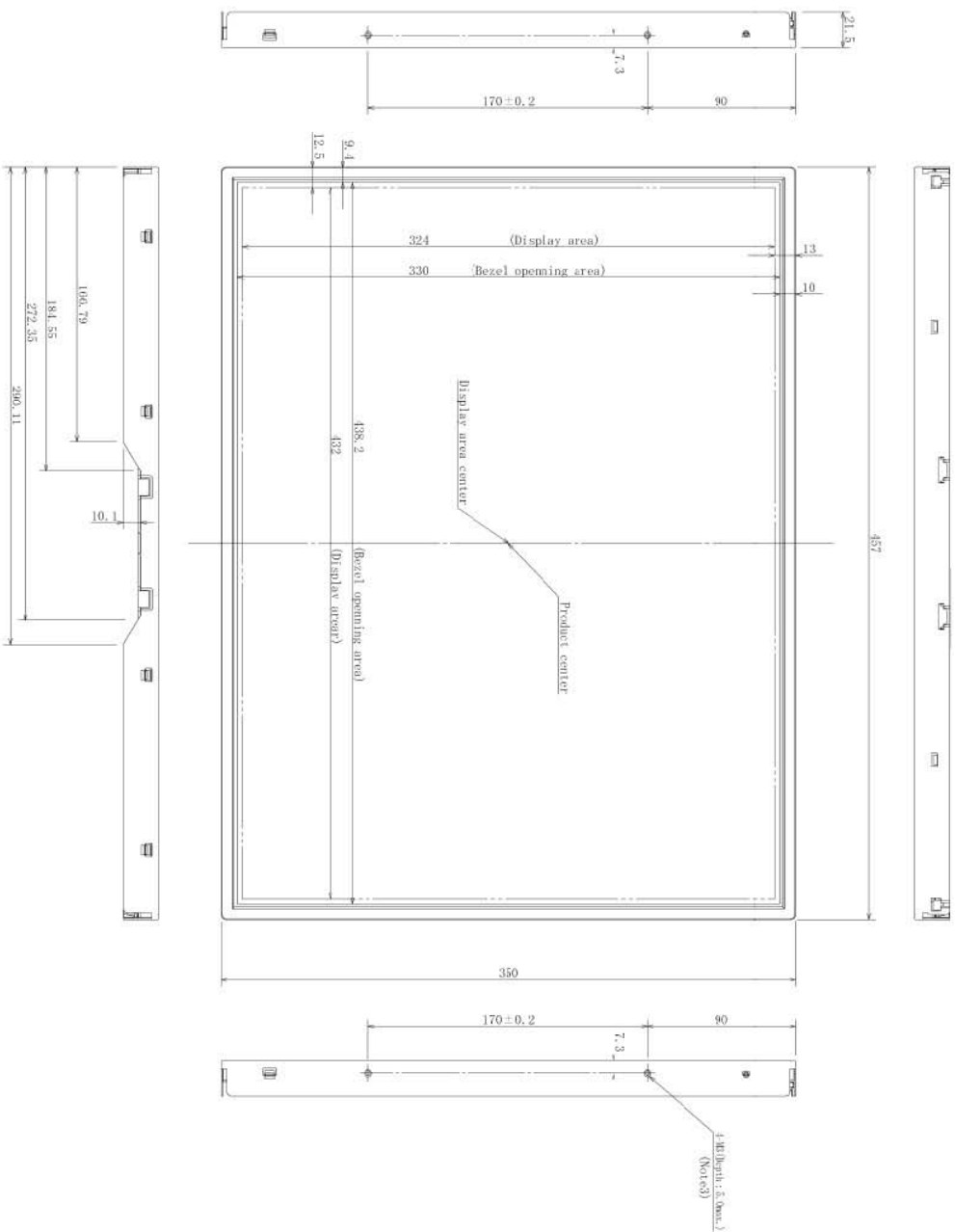
×: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is above the limitation level of SJ/T11363-2006 standard regulation.

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8. OUTLINE DRAWINGS

8.1 FRONT VIEW



Note1: Not shown tolerances of the dimensions are $\pm 0.5 \text{mm}$.

Note2: The torque for product mounting screws must never exceed $0.735 \text{N}\cdot\text{m}$.

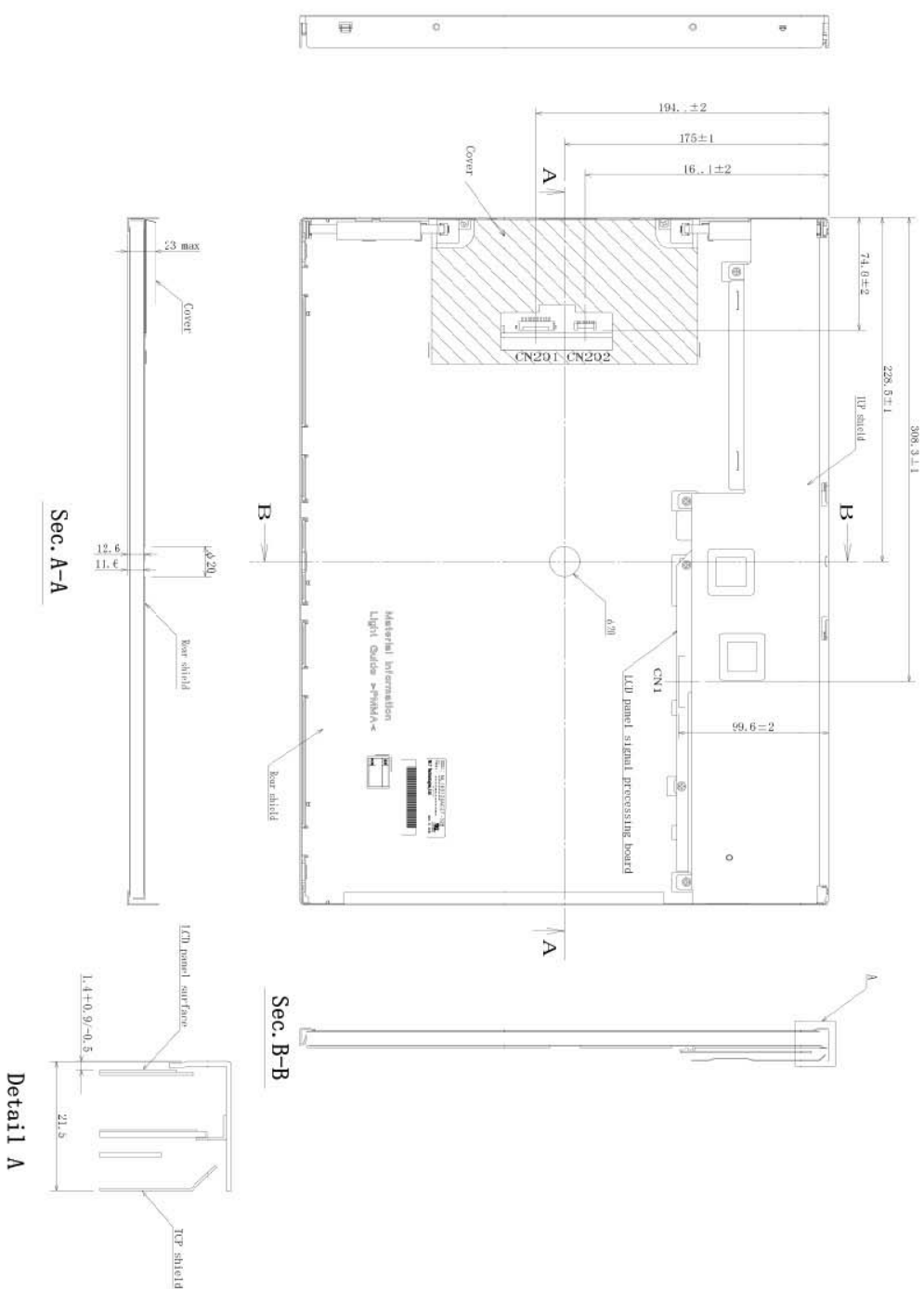
Note3: The length of product mounting screws from surface of plate must be $\leq 5.0 \text{mm}$.

Note4: The values in parentheses are for reference.

Unit: mm

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8.2 REAR VIEW



Note 1: Not shown tolerances of the dimensions are $\pm 0.5\text{ mm}$.

Note 2: The torque for product mounting screws must never exceed 0.735N·m.

Notes: The length of product mounting screws from surface of plate must be ≤ 5.0 mm

Note4: The values in parentheses are for reference.

Unit: mm